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Assessment of cost-effective feed supplement on growth and economics of TANUVAS Aseel birds

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ABSTRACT

Backyard poultry farming significantly contributes to rural livelihoods by enhancing nutritional security and generating a supplementary income for small-scale farmers. However, the economic sustainability of this practice is challenged by high feed costs, which constitute approximately 60% of total production expenses. The present study assessed the effects of incorporating azolla (*Azolla pinnata*) as a dietary supplement on the growth performance and economic viability of TANUVAS Aseel chicken reared under backyard conditions. A total of 300 birds were allocated to five different dietary treatment groups: T1 (foraging only), T2 (foraging + 50 g concentrate), T3 (foraging + 50 g concentrate + 10% azolla), T4 (foraging + 50 g concentrate + 20% Azolla), and T5 (foraging + 50 g concentrate + 40% azolla). Results indicated that T4 birds exhibited significantly higher ($P<0.01$) body weight (2722.84±29.06g at 40 weeks), improved feed conversion efficiency (4.95±0.29), increased egg production (107.22±0.26 eggs per bird), and better fertility (91.22±0.26%). Economic analysis revealed that T4 had the highest net profit (Rs. 3807.90±144.82) and cost-benefit ratio (2.06±0.04), demonstrating the economic advantage of azolla inclusion in diet. The study concluded that supplementing TANUVAS Aseel chicken with 20% azolla enhanced growth, reproductive performance, and profitability without any adverse health effect. These findings supported incorporation of azolla as an affordable and sustainable feed option in backyard poultry farming to enhance productivity and boost economic gains for small-scale farmers in Tamil Nadu.

Keywords: Azolla Supplementation and Low-Cost Feed, Backyard Poultry, TANUVAS Aseel

Backyard poultry farming is a crucial component of rural livelihoods, offering nutritional security and additional income to small-scale farmers, especially in the face of changing climate conditions (Pathak *et al.* 2013). However, traditional backyard poultry systems often rely on indigenous chicken breeds with low productivity, limiting economic benefits. TANUVAS Aseel, an improved dual-purpose backyard poultry variety, offers higher egg and meat production while maintaining the desirable traits of indigenous birds such as disease resistance and adaptability to scavenging systems. Despite its advantages, the profitability of backyard poultry farming is largely influenced by feed expenses, comprising nearly 60% of the overall production cost. To enhance economic viability, the use of locally sourced feed alternatives like azolla (*Azolla pinnata*) has gained attention as a sustainable alternative to commercial poultry feed (Alalade and Iyayi, 2006).

Azolla, an aquatic fern that floats freely, is well known for its high nutritional value and its capability to fix atmospheric nitrogen through a symbiotic relationship with the cyanobacterium Anabaena azollae (Ivan and Thuget, 1995). With a crude protein content ranging from 25-35% on a dry matter basis, it is also rich in essential amino acids, vitamins, minerals, and β-carotene, making it an effective feed supplement for poultry, livestock, and aquaculture (Makkar *et al.* 2014). Research has shown that incorporating azolla into poultry diets enhances growth performance, feed conversion efficiency, and profitability. For example, Basak *et al*. (2002) found that substituting 20% of commercial poultry feed with fresh azolla led to a significant reduction in feed costs without compromising growth in broiler chicken. Likewise, Joshi et al. (2020) reported that providing backyard poultry with 200 g of fresh azolla per bird daily enhanced weight gain and accelerated market readiness, ultimately improving the benefit-cost ratio for smallholder farmers.

The role of azolla as an economical poultry feed ingredient has been further validated through studies investigating

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its influence on meat quality and physiological aspects. Research by Parthasarathy *et al*. (2002) demonstrated that adding azolla to broiler diet enhanced protein and energy utilization efficiency without causing any negative health impacts. Similarly, Subramanian (2021) found that incorporating azolla at inclusion levels of 5-15% promoted body weight gain while significantly lowering feed costs, without affecting overall poultry performance. Given its potential as a sustainable feed resource, the present study was designed to assess its effects on the growth performance and economic viability of TANUVAS Aseel birds raised under backyard conditions. Key parameters analyzed include weight gain, feed efficiency, and overall production economics. By integrating Azolla into backyard poultry farming systems, the study aims to offer affordable solutions for improving rural livelihoods, decreasing reliance on commercial poultry feed, and fostering environmentally sustainable poultry farming in Tamil Nadu.

MATERIALS AND METHODS

The study was carried out at Krishi Vigyan Kendra, Dharmapuri, along with selected farmers' holdings across all blocks of Dharmapuri district, as part of a University Research Project. The experiment involved five dietary treatments, with four replicates and each contain 15 per replicate. Azolla was cultivated in pre-established pits at KVK Dharmapuri, as well as in newly constructed pits at the farmers' fields. The pits, measuring 6 × 3 × 1 feet, were built using bricks and tarpaulin sheets. Each pit was layered with a 5 cm thick soil bed made up of 30 kg of red soil, followed by the addition of water up to a height of 15–20 cm. To enhance nutrient availability, a slurry mix of 3 kg of fresh cow dung and 35 g of superphosphate in 15 L of water, was added the pits. Each pit was inoculated with 500 g of Azolla pinnata culture, and harvesting commenced on the 20th day post inoculation.

A total of 300 TANUVAS Aseel chicken were procured from Poultry Research Station (PRS), TANUVAS, Chennai. The chicks were brooded at KVK Dharmapuri under standard conditions until 8 weeks of age, after which they were randomly allocated to five dietary treatment group: T1 (foraging only), T2 (foraging + 50 g concentrate mixture), T3 (foraging + 50 g concentrate mixture + 10% Azolla), T4 (foraging + 50 g concentrate mixture + 20% azolla), and T5 (foraging + 50 g concentrate mixture + 40% azolla). The birds were housed in well-ventilated sheds with adequate floor space, light, temperature, and relative humidity control with unrestricted access to feed and were water for the entire duration of the experiment. Standard health management practices, including vaccination and deworming were followed. Growth performance parameters, including weekly body weight, feed consumption were recorded while feed conversion efficiency was calculated up to 40 weeks of age. Economic feasibility was assessed by calculating the total feed cost per bird, revenue from live bird sales, and the benefit-cost (B C) ratio. The proximate analysis of azolla conducted at the Veterinary College and Research Institute, Namakkal (Table 1) and the composition of the concentrate mixture utilized in this study is shown in Table 2.

Table 1: Azolla's chemical composition analysis

S.no	Nutritional Unit	Azolla (% on dry matter basis)
1	Moisture (%)	95.18
2	Crude Protein	23
3	Crude fibre	11.43
4	Crude fat	3.77
5	Crude Ash	22.92
6	Gross Energy (Kcal/kg)	3984

Table 2: Composition of concentrate mixture (Handbook of Animal Husbandry, 2008)

1	Maize	27.10
2	Wheat bran	15
3	Rice Police DOC	40
4	Soyabean meal	10
5	Fish meal	6
6	Lime stone	0.8
7	Bone meal	0.6
8	Mineral Mixture	0.1
9	Toxin binder	500 g/ton
10	Common Salt	0.4

Statistical analysis: The data were evaluated through one-way ANOVA using the IBM SPSS Statistics software, Version 23.0 for Windows.

RESULTS AND DISCUSSION

The body weight performance of TANUVAS Aseel birds fed varying levels of Azolla meal is displayed in Table 3. A progressive increase in average body weight was observed in T3, T4, and T5 compared to T1 and T2. The birds' average final body weight showed an upward trend across the supplemented groups and recorded, a body weight of 2722.84±29.06g at the 40th-week in the T4 group which was significantly higher than in other groups

There were no negative effects on the weekly body weights of TANUVAS Aseel chicken**s**. The control group, T1 recorded a body weight of 1844.95±0.56, while the corresponding live weight in T2, T3, and T5 were 1949.55±0.5, 2406.19±50.60, and 2290.67±51.91, respectively. The decline in body weight observed in T5 may be attributed to the higher NDF content in azolla meal, which serves as a key limiting factor for efficient utilization in monogastric animals (Mamata, *et al.* 2018). The inclusion of fresh azolla also contributed to improved body weight gain in TANUVAS Aseel chicken**s**, likely due to its high nutritional profile, particularly its protein, vitamin, and mineral content (Bidya *et al.* 2018; Chandan *et al.* 2023).

Table 3. Average body weight (g) recorded for TANUVAS Aseel under different levels of azolla supplementation

Treatment	Weekly body weight (in gms)									
	1st week	2nd week	3rd week	4th week	5th week	6th week	7th week	8th week	24th week	40th week
T1	25.59 ± 0.12 a	60.62± 0.13 a	124.62± 0.13 a	141.56± 0.20 a	172.39± 0.29 a	247.42± 0.29 a	313.57± 0.41 a	394.18± 0.48 a	1325.40 ± 0.61 a	1844.95± 0.56 a
T2	30.68 ± 0.16 b	73.60± 0.2b	136.47± 0.3b	159.62± 0.2a	192.46± 0.3b	287.08± 0.2b	372.97± 0.3b	423.99± 0.5b	1854.79 ± 0.6b	1949.55± 0.5b
T3	33.47 ±0.78c	74.83±0.76b	133.04± 0.9b	310.27± 24.5c	235.13± 4.7d	326.32± 4.3d	421.23± 5.3d	465.10± 4.50 c	2299.85 ± 49.31 d	2406.18± 50.60 d
T4	36.70 ± 0.94 c	78.62± 0.93 c	149.10± 1.6c	220.12± 14.61b	254.66± 1.51	344.97± 1.49 e	453.55± 2.68 e	529.90± 6.27 d	2519.91 ± 18.49 e	2722.84± 29.06 e
T5	32.15 ±1.19 c	74.15± 1.22 b`	134.57± 2.45 d	169.66± 4.65a	205.18± 6.29 c	317.09± 3.90 c	399.61± 6.93 c	453.33± 9.86 c	2170.10 ± 41.58 c	2290.67 ± 51.91 c

Different superscript a, b, c, d, e indicate significant differences at P<0.01 within in each column

Azolla meal was effectively incorporated into the diet of TANUVAS Aseel chickens, yielding highly favorable results (Dhumal *et al.* 2009), which were also observed in this study with A. pinnata. Pillai *et al.* (2002) highlighted that, beyond its nutritional content, Azolla contains beneficial compounds such as carotenoids, bio-polymers, and probiotics, which play a role in enhancing body weight gain and maintaining bird health. Senthil *et al*. (2020) emphasized that Azolla is highly digestible for poultry and livestock due to its superior protein quality and low lignin content, contributing to improved weight gain. In this study, TANUVAS Aseel birds fed azolla, both as supplemented and replaced groups, exhibited increased body weight gain compared to the control group, aligning with the findings of Rai *et al*. (2012). Likewise, Lakshmanan *et al*. (2017) had also identified Azolla as a valuable feed ingredient, demonstrating its nutritional advantages in broiler chickens, which are comparable to the outcomes observed in TANUVAS Aseel birds in the present experiment.

The influence of azolla supplementation on livability, marketing weight, age at egg production, and overall performance is detailed in Table 4. Among the experimental groups, T4 recorded the highest livability up to 40 weeks at 99.22±0.26, surpassing the other treatments. The lowest mean feed efficiency was observed in T1 at 6.60±0.22, whereas T4 exhibited a better value at 4.95±0.29. The age at egg production was lowest in T4 at 171.22±0.26 days, followed by T5, T3, T1, and T2, which recorded 175.40±0.30, 177.95±0.29, 178.00±7.90, and 185.60±0.37 days, respectively. Egg production up to 40 weeks was highest in T4 at 107.22±0.26 eggs, followed by T5, T3, T2, and T1, which recorded 103.40±0.30, 102.35±0.29, 93.60±0.37, and 84.80±0.55 eggs, respectively. The mean marketing weight (kg) was significantly higher (P>0.01) in T4 at 2533.22±0.26, followed by T3, T5, T2, and T1 at 2346.35±0.29, 2126.40±0.30, 1851.60±0.37, and 1320.10±1.57, respectively. The increased marketing weight observed in T4 may be attributed to the higher protein content in azolla, supporting enhanced growth performance. The highest mean egg weight (g) was recorded in T4 at 53.22±0.26, followed by T5, T3, T2, and T1 at 51.40±0.30, 51.35±0.29, 52.60±0.37, and 51.20±0.44, respectively. Hatchability (%) was also significantly higher in T4, followed by T5, T3, T2, and T1, with the values of 81.40±0.30, 81.35±0.29, 81.60±0.37, and 72.50±0.69, respectively. The present study indicated that livability, feed efficiency, age at egg production, egg production up to 40 weeks, marketing weight, and hatchability were positively influenced by azolla supplementation, as it provided essential nutrients required for optimal growth. These findings aligned with the research of Alalade and Iyayi (2006) and Poonam and Praveen (2020).

The impact of azolla dietary supplementation on body weight, sexual maturity, and body measurements

Table 4. Effect of azolla dietary supplementation of on the livability, marketing weight, age at egg production and marketing weight

Treatment	Livability (%) up to 40 weeks	Feed efficiency	Age at egg production	Egg production (up 40th week)	Marketing weight (kg)	Egg weight (g)	Hatchability (%)
T1	97.20±0.49 a	6.60± 0.22 a	178.00±7.90 a	84.80±0.55 a	1320.10±1.57 a	51.20 ± 0.44 a	72.50 ± 0.69 a
T2	97.60±0.3 a b	5.30 ±0.37 c	185.60 ±0.37 c	93.60 ±0.37 b	1851.60±0.37 b	52.60 ± 0.37 b	81.60 ± 0.37 b
T3	98.35±0.293 bc	4.95 ±0.29b	177.35 ±0.29 a b	102.35 ± 0.29 c	2346.35±0.29 d	51.35 ± 0.29 a	81.35 ± 0.29 b
T4	99.22±0.26c	4.95 ±0.29b	171.22 ±0.26 a b	107.22 ± 0.26 d	2533.22±0.26 a	53.22 ± 0.26 b	86.22 ± 0.26 c
T5	99.40±0.30c	4.90 ±0.30b	175.40 ±0.30 a b	103.40 ± 0.30 e	2126.40±0.30	51.40 ± 0.30 a	81.40 ± 0.30 b

Different superscript a, b, c, d, e indicate significant differences at P<0.01 within in each column

Table 5. Effect of azolla supplementation on the body weight, sexual maturity and body measurement

Treatment	Body weight gain 24th weeks of age		Age at sexual maturity (days)	Fertility (%)	Body measurement (cm)			
	Male	Female			Neck length	Thigh length	Drumstick	Shank length
T1	1325.40 ± 0.61 [a]	1226.10 ± 1.02 [a]	194.00 ± 0.00 [a]	85.00 ±0.00 [a]	21.10 ± 0.10 [a]	10.00 ± 0.00 [a]	16.00 ± 0.00 [a]	11.00 ± 0.00 [a]
T2	1854.79± 0.6[b]	1746.60 ± 0.37 [b]	187.60 ± 0.37 [c]	87.60 ± 0.37 [b]	23.60 ± 0.37 [bc]	12.60 ± 0.37 [bc]	17.60 ± 0.37 [bc]	12.60 ± 0.37 [bc]
T3	2299.85 ± 49.31 [d]	2136.35 ± 0.29 [d]	185.35 ± 0.29 [b]	90.35 ± 0.29 [d]	23.35 ± 0.29 [b]	12.35 ± 0.29 [b]	18.35 ± 0.29 [c]	13.35 ± 0.29 [c]
T4	2519.91 ± 18.49 [e]	2346.22 ± 0.26 [e]	181.22 ± 0.26 [a]	91.22 ± 0.26 [e]	24.22 ± 0.2[b]	13.22 ± 0.26 [c]	18.22 ± 0.26 [bc]	13.22 ± 0.26 [c]
T5	2170.10 ± 41.58 [c]	2016.40 ± 0.30 [c]	191.40 ± 0.30 [d]	88.40 ± 0.30 [c]	24.40 ± 0.3[c]	12.40 ± 0.30 [b]	17.40 ± 0.30 [b]	12.40 ± 0.30 [b]

Different superscript a, b, c, d, e indicate significant differences at P<0.01 within in each column

is illustrated in Table 5. At the 24th week, the average mean body weight of TANUVAS Aseel chickens was highest in T5, with cocks weighing 2436.22±0.26 and hens 2146.22±0.26, followed by T3, T5, T2, and T1. There were no changes in the incidence of disease between of the treatment groups. The highest mean average fertility (%) was observed in T4 at 91.22±0.26 compared to the other groups, with T5, T3, T2, and T1 following in that order. The average body measurements (cm) for neck length, thigh length, drumstick and shank length were significantly greater in T5 compared to the other groups. The study suggested that supplementing TANUVAS Aseel chicken with 20% Azolla led to increased body weight at the 24th week, earlier sexual maturity, improved fertility, and enhanced body measurements compared to other groups, likely due to the high protein content, essential amino acids, and bioactive compounds that contribute to improved growth and reproductive performance (Chandan *et al.* 2023).

Economic analysis was carried out by evaluating the total feed expenditure for TANUVAS Aseel birds from the 4th to the 40th week of age and comparing it with the income generated from their sale after 40 weeks. The average weights produced were 1844.95±0.56, 1949.55±0.5, 2406.18±50.60, 2722.84±29.06, and 2290.67±51.91 in the T1, T2, T3, T4, and T5 groups, respectively. The corresponding economic output at the conclusion of the experiment was Rs. 3463.50±129.25, Rs. 5000.00±178.92, Rs. 6032.20±161.77, Rs. 7206.20±201.02, and Rs. 5130.90±370.73, respectively. Thus, the net profit was Rs. 404.00±17.30 in T2 and Rs. 1602.00±72.60, Rs. 2522.40±79.49, Rs. 3807.90±144.82, and Rs. 1683.90±323.93 in the T2, T3, T4, and T5 groups, respectively, resulting to a cost-benefit ratio of Rs. 1.128±0.00 in T1 and 1.4000±0.00, 1.6700±0.03, 2.0600±0.04, and 1.5600±0.06 in the T2, T3, T4, and T5 groups, respectively (Table 6). The rearing cost of TANUVAS Aseel birds up to 8 months of age exceeds 50% due to their extended growth period. However, this can be minimized by incorporating azolla into their diet, although, the findings of Parathasarathy (2002) differed while aligning with the observations of Chandan *et al*. (2023).

The study demonstrated that supplementing TANUVAS Aseel chickens with azolla significantly improved growth performance, feed efficiency, and economic viability under backyard conditions. Birds in the T4 group (20% azolla) supplementation exhibited the highest body weight, fertility, egg production, and market weight, with no adverse effects on health. The cost-benefit analysis revealed that azolla supplementation reduced feed cost and increased net profit, making it a viable alternative to commercial poultry feed. The findings underscored the potential of azolla as a sustainable, nutrient-rich feed supplement for smallholder poultry farmers. Integrating azolla into backyard poultry

Table 6. Effect of azolla dietary supplementation on the economics

Treatment	Gross cost Rs.	Gross return Rs.	Net return Rs.	BCR
T1	3079.50 ±115.85 [a]	3463.50±129.25[a]	404.00±17.31[a]	1.1280±0.00[a]
T2	3388.00± 112[ab]	5000.00±178.92[b]	1602.00±72.60[b]	1.4000± 0.00[b]
T3	3509.80± 123[c]	6032.20±161.77[c]	2522.40±79.49[c]	1.6700± 0.03[d]
T4	3398.30± 126[ab]	7206.20±201.02[d]	3807.90±144.82[d]	2.0600± 0.04[e]
T5	3447.00±111[b]	5130.90±370.73[b]	1683.90±323.93[b]	1.5600±0.06[c]

Different superscript a, b, c, d, e indicate significant differences at P<0.01 within in each column

systems can enhance rural livelihoods, promote sustainable poultry production, and reduce dependence on expensive commercial feeds.

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